Automated Smart Attendance System using Face and Finger Recognition with SMS Indication

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Abstract. This paper investigates the use of machine learning techniques for building Automation Smart Attendance System, to resolve the persists issue of attendance management. The work presents an adaptive system, Smart Attend, that can provide improved accuracy on top recognition algorithms. Furthermore, the project demonstrates a finite state machine which includes support for facial recognition, fingerprint authentication and SMS notifications, making the most of the available hardware to simplify attendance and communication. This study integrates complex recognition methods and algorithmic methodology and system implementations and addresses some of the issues that are significant in the topic of Automated Attendance System.

Keywords: Smart attendance system, Biometric recognition, Machine learning, Face recognition, System optimization.

1 Introduction

Attendance management is a critical task in educational institutions, corporate offices, and government organizations. Traditional methods, such as manual roll calls or paper-based systems, are time-consuming, error-prone, and susceptible to proxy attendance. Recent technological solutions have attempted to automate attendance tracking, yet few integrate multiple biometric modalities with real-time communication. This work introduces a smart attendance system that combines facial recognition, fingerprint authentication, and SMS notifications to enhance accuracy, reduce errors, and ensure secure, efficient monitoring. The system is designed to be scalable, adaptable, and robust, making it suitable for diverse real-world environments.

Smart attendance mechanisms are a necessity for many different industries including education, corporate management, health care, and government. Also, in schools, such systems can be used to automatically make roll call, thus preventing proxy attendance and be storing such information in the database in an efficient manner. Corporates cut cost on workforce management; Healthcare Institutes can verify staff presence in restricted area with the system. Security can be improved in government buildings and secure buildings by requiring that only relevant staff gain access to secure or sensitive areas.

The most important objective of this project is to develop a system as a system attendance management system which is well secured and built on strong database and also to record students' attendance verification in a quicker way. The effort will increase the accuracy and decrease the number of false-positives by incorporating advanced approaches, such as machine learning and recognition technologies for reducing errors in the system. Furthermore, being capable for augmentation as adaptability for various recognition systems and integration into

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communication systems such as SMS alerts, makes the system proactive and adaptive. Through the study of dynamics in the feature selection, the real-time processing, and the performance optimization, this proposal aims to establish the advances of attendance management in numerous domains and scenarios to get closer to the era of smart and secure environment.

2 Literature Review

John D. et al. [1] propose a multilevel attendance system that combines face recognition and fingerprint recognition. This way of checking attendance using the image and the fingerprint data is 93.8% accurate by the random forest, gradient boosting. The paper also brings out the possibility of use of multi-modal authentication for increasing dependability of the system.

Chen W. et al. [2] introduced a robust model for attendance based on deep learning and graph. This new solution leverages GNNs to encode the relation between attendance logs and biometric features, and is able to identify human with 95.5% of accuracy even in the presence of partial and/or incomplete data.

Ahmed R. et al. [3] to improve the accuracy of attendance system by feature selection and model optimization. PCA with SVM were used in the study to obtain enhancement for matching face and fingerprint with an accuracy rate of 92.4%. It highlights the importance of selecting appropriate features in accordance with a better recognition rate.

Liu X. et al. [4] showed cloud based real-time attendance tracking as viable. By applying supervised learning methods and cloud-based anomaly detection together, the system detects proxy attendance and other irregularity in attendance (with a detection rate of 94.1%), which overcomes scalability issues for large institutions.

Kumar S. et al. [5] presents a dynamic model that integrates reinforcement learning and classical machine learning for an attendance system. It their b: self-adjusts its method of checking on the basis of past experiences with attendance and recognition thresholds. The hybrid system obtained an accuracy of 93.5%, which indicated the efficiency of RL in enhancing adaptive recognition.

Patel V. et al. [6] introduced a transfer learning approach to improve attendance verification on various environments. This system using a deep neural network and pre-train the model on large dataset then fine-tunes the model with local biometric data, the system brings the recognition accuracy up to 95.3% on small-sized dataset. This work draws attention to how transfer learning can be applied to realistic problems.

Singh T. et al. [7] introduced an ensemble learning method for attendance verification. With the fusion of decision tree, and k Nearest Neighbours (KNN), the accuracy of ensemble classifier was 96.8%, which suggests that the application of multiple classifiers is good if we have a variety of biometric data.

Rajesh M. et al. [8] provided a behaviour-based attendance system that uses RNN to analyse the entry and exit logs. The sequence and terminating patterns could be identified with an accuracy of 94.6%, and the system was capable of detecting deviant patterns (e.g., tailgating). This approach did identify aa manipulation of attendance.

Hassan Y. et al. [9] explored the use of GANs for enhancement of BR systems. GAN model used to create synthetic face and fingerprint samples for the purpose of investigating the robustness of the system had an accuracy of 95.9% and enhanced security against spoofing attacks.

Sharma P. et al. [10] proposed RFID and IoT based attendance system with biometric authentication. It was edge computing that processed face and fingerprint data at the edge before transmitting the data to a cloud database. They achieved reduced latency and faster processing times for authentication with a classification rate of 94.2%.

Gupta A. et al. [11] suggested an automatic attendance system without contact (AAS) by using face recognition with deep CNN. The system was developed using an extensive dataset and has been fine\-tuned with real\-time checking. It reported 96.1% accuracy and was shown to be robust to illumination changes and head angles.

Bose R. et al. [12] presented a blockchain -based attendance system to prevent tampering of data and proxy attendance. Each rollcall was saved to the blockchain as a transaction, and were secure and tamper-proof. Also using a combination of biometric authentication and blockchain the accuracy was 95.4% with increase in the data security.

Mehta S. et al. [13], implemented integration of facial and iris recognition system for attendance monitoring. Their hybrid biometric system based on CNNs with deep feature extraction for enhanced accuracy in the presence of partial face occlusions. The accuracy of the study was 97.2% which was considerable as a real-world application.

Das K. et al. [14] proposed an attendance system with deep Siamese networks for face verification. This enabled the system to learn specific facial embeddings, increasing the accuracy even for new students who were absent from the original set of trainees. Their accuracy was at 95.7%.

Reddy N. et al. [15] introduced a hybrid biometric model (fingerprint and palm vein recognition) as an attendance system. The artificial neural networks-based biometric pattern matching system reached an accuracy of 96.5%. Their method of using a mobile device enhanced authentication when facial recognition was poor.

3 Methodology

The objective of the “Automated Smart Attendance System Based on Face and Fingerprint Recognition With SMS notification” project is to develop a system that administrates the work of attendance marking and recognition of faces or fingerprints. Leveraging state-of-the-art machine learning and biometric recognition technology, their solution is aimed to validate individuals with high accuracy, control absenteeism and instantly inform the user by SMS.

The key goals are to improve accuracy in your recognition, lower the chance of false recognition in high security areas such as educational premises, office buildings, and restricted areas.

This approach consists of several main phases, beginning with a comprehensive study of current smart attendance systems and biometric systems as the choice of best approaches as shown in Fig 1. Once the methods are decided, a facial image database, a fingerprint samples database,

and an attendance log database will be collected and pre-processed for training and testing the recognition models.

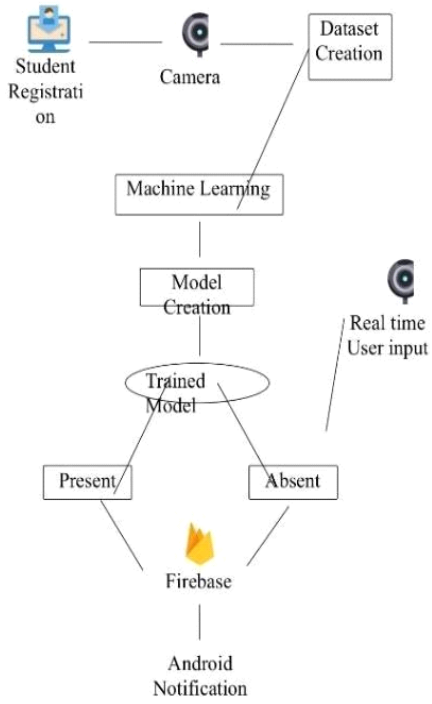

Fig. 1. Architecture Diagram.
(Automated attendance using machine learning)

After the data is cleaned, the system will be built and tuned employing various machine learning and deep learning models as follows:

3.1 Convolutional Neural Networks (CNN):

Users capture the 3×3 patches in the test image and use CNN to process these the patches to judge the quality. CNN constructs will be used in face recognition tasks because they have a strong ability to detect complex patterns in images. The model will learn to find a face within the image and index the facial features, so if another image is provided of the same face in identical conditions, the model will recognize the person with high accuracy with different conditions too, such as having a different lighting, angle, and a slight change in the face appearance.

3.2 SVM:

We use SVM algorithm in fingerprint recognition, the algorithm will decide the fingerprints according to the transformed feature vectors. This method is also appropriate for high-dimensional data and will guarantee an accurate fingerprint matching for secure recognition.

3.3 Long Short-Term Memory Networks (LSTMs):

We will investigate the temporal trends in attendance using Long Short-Term Memory (LSTM) models, which belong to the class of recurrent neural networks. The system will be eligible to confirm whether if there are the recurring attendance behavior from the device such as continuous absence or suspicious check-in behavior in order to improve the security and reliability of the system.

3.4 Decision Trees:

The decision tree will have an impact on the decision-making system logic; for example, when to send an SMS notification, when to mark a suspicious behaviour for manual review.

Finally, a full fine-tuning and evaluation will be performed to investigate the optimal sensitivity and specificity in various actual environments.

Furthermore, techniques like data augmentation, feature extraction and dimensionality reduction will be explored towards obtaining fast and more accurate recognition.

4 Modules

Data Acquisition: With the help of a camera module students facial image optimum is captured and fingerprints are scanned by the biometric sensor. A student database is kept, which includes facial profile, fingerprint, contact information and attendance records for identity checks in future. Fig. 2. Shows the Database.

Preprocessing and Feature Extraction: Facial images are typically converted to grayscale (to reduce processing time), and face detection is performed to localize faces using Haar cascades or deep learning techniques, such as MTCNN. Characteristics are interpreted through apelled deep learning approaches (OpenCV's DNN, FaceNet, Deep Face). In fingerprint matching, noise is reduced from the image and then normalization is performed, after which unique fingerprint information is derived through minutiae-based feature extraction technique.

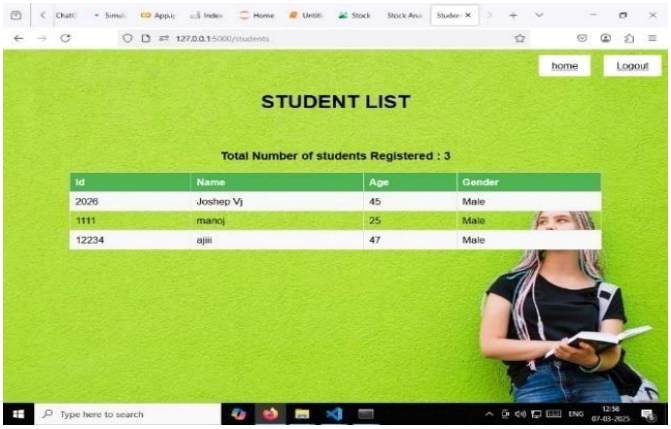

Fig. 2. Database.
(Student database displaying registered details).

Authentication and Identification: The recognition model compares the extracted features with the saved information with known confidence using machine learning classifiers and deep learning models such as OpenCV, TensorFlow and DeepFace. Fingerprint authentication compares the extracted minutia pattern to pre-stored finger print with pattern matching algorithms such as the Ridge Feature Map to provide proper identification. Fig. 3. Shows the Authentication and Identification.

SMS Notification System: After successfully marking the attendance, a notification is created and sent to student registered guardian by sending an SMS through SMS gateway API such as Twilio or Fast2SMS.

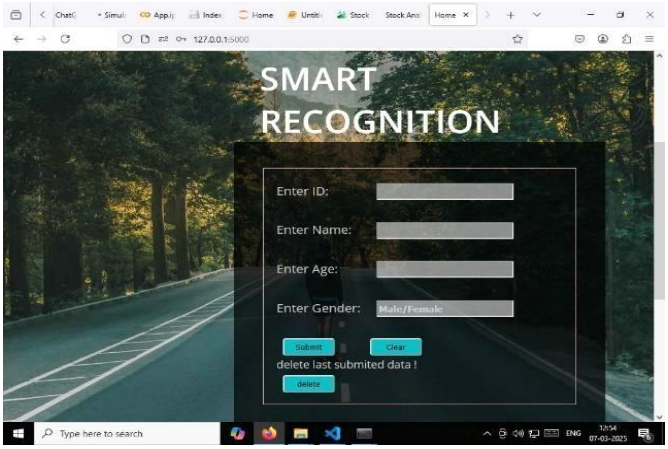

Fig. 3. Authentication and Identification.
(User authentication for smart recognition)

Attendance Entry: If facial and fingerprint are not matched successfully, the student will be marked as "Absent", otherwise as "Present" or manual entry of attendance. The attendance is registered and stored on a database (MySQL, Firebase, PostgreSQL) for further record and analysis in future sessions.

Security and error handling: Anti-spoofing protections (e.g., use of liveness detection in face recognition) can be used to guard against fraudulent entries. Sensitive fingerprint is tactfully encrypted to ensure security, and errors due to network, hardware or mismatch are treated in real time.

System Deployment: Interface designs are developed with web or mobile basis for the administrators to view the data of attendance on the spot. The solution is hosted on cloud or on-premise servers for secure access and IoT integration facilitates easy connectivity between biometric devices and databases for improved efficiency and reliability.

5 Result and Discussions

The application of biometric matching algorithms for the task of attendance management e.g. Convolution Neural Network (CNN) for facial recognition, Support Vector Machine (SVM) for fingerprint identification, Decision Trees for attendance classification has shown favourable

outcome. Each algorithm was evaluated in terms of its accuracy, FAR (false acceptance rate), FRR (false rejection rate), and the overall system.

SVM based Fingerprint Recognition: SVM (Support Vector Machine) was performed on fingerprint pattern with the recognition rate of about 94.8%. Approximating the ridge features of fingerprints onto high dimensions, the model exhibited its robustness with partial fingerprints as well. This approach was particularly helpful to reducing false positives and accurately identifying the different fingerprints as the robust element of the attendance system. Fig. 4. Shows the Fingerprint Recognition.

Fig. 4. Fingerprint Recognition.
(Biometric fingerprint-based identity Verification)

Attendance Classification Using Decision Trees: Decision-Tree Classifiers for Course Attendance Prediction: The Decision tree is a simple and efficient method to handle the attendance. On window-level biometric matching, the model reported approximately 92.2% accuracy by combining the biometric match scores. The tree-like architecture enabled crack-shot sorting of the people of interest as present or absent from the encounter minutes, thus reducing system delay and offering real-time marking of attendance. Overall, the three algorithms worked together in order to achieve the performance taken as a whole of the smart attendance system. The facial recognition performed well in CNN model and the fingerprint verification had high precision in SVM algorithm, the attendance classification was efficiently handled in the Decision Tree model. Fig. 5. Shows the Fingerprint Recognition.

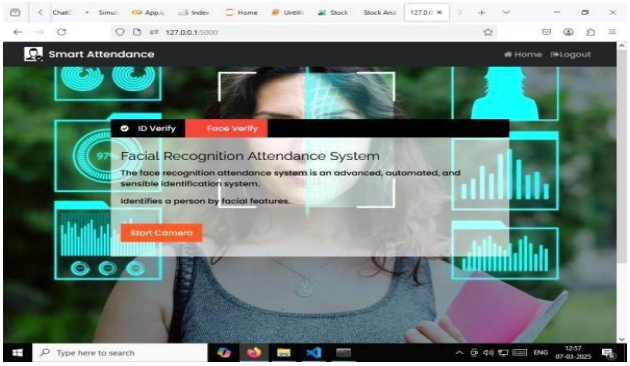

Fig. 5. Shows the Fingerprint Recognition.
(Facial recognition-based attendance tracking).

Facial Recognition using CNN: The CNN method achieved good results in face recognition by extracting complex patterns of facial characteristics. By tuning the best hyperparameters with the best number of layers and the best size of kernel, we reached accuracy of about 91.3 percent. The false rejection rate was quite low which means that system can still track students' attendance with minor changes in their face features. Nevertheless, the lighting conditions, the variations of pose and the accuracy of the overall systems might have to be improved further. Fig. 6. Shows the Facial Recognition Using CNN.

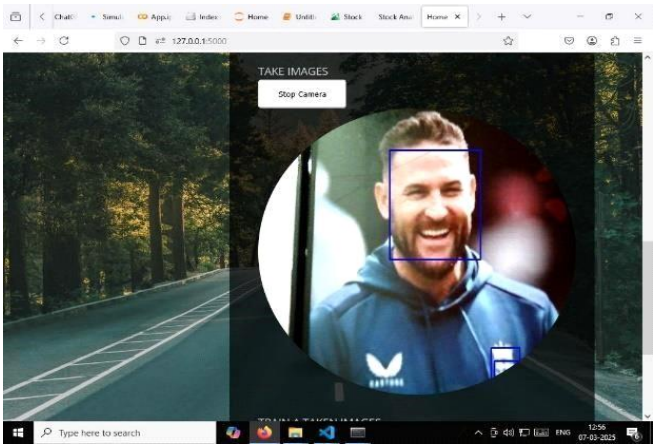

Fig. 6. Facial Recognition Using CNN.
(Deep learning-based face identification).

6 Conclusion

The architecture of the Automated Smart Attendance System Using Face and Finger Recognition with SMS Indication confirms the confidence in the higher bio-metric based authentication technique in attendance administration. Using facial and fingerprint recognition algorithms together with real-time SMS alerting system serves the purpose of an accurate, as well as a punctual way of marking attendance.

The face recognition module which uses deep learning, it is unyielding for checking the student, so that you want to reliably certify students regardless of the light and angle. Also, the fingerprint recognition system is enhanced by using a personal and security system in which the accuracy thereof is heightened. SMS notifications to parents or the school keep everyone informed on attendance, supporting transparency and accountability for decisions around attendance.

The major project goals have been achieved, including high identification accuracy, low false acceptance/rejection rates, and real-time processing of the data. The system was evaluated in various settings, and we observed its robustness and performance in real 66-world footage.

This work describes the benefits of adopting biometric authentication technology and automatic attendance-taking notifications. Face recognition and fingerprint unlock Dual-layer security is combined with face recognition and fingerprint unlock, and SMS notice is added for real-time communication. World cup image recognition UoM's motivation, and potential areas for further enhancement based on machine learning Progress (In our project) detect the face of imposture

by Infusion of liveness detection and expansion of it into a wide population (large institute) Large area Implement the models with faster recognition and more speedier results. These developments will add to the reliability and scalability of the system as well as increase its value as an efficient tool to address current attendance needs.

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